In the Claims:

This listing of claims will replace all prior versions and listings of claims in the application:

1-45. (Canceled)

46. (New) A tandem mass spectrometer comprising:

a pulsed ion source;

a parent ion separator in the form of a first time-of-flight mass spectrometer;

a fragmentation cell;

a second time-of-flight mass spectrometer; and

a time nested data acquisition system acquiring fragment mass spectra for multiple parent ions,

wherein for ions of a same mass-to-charge ratio, a time-of-flight in said first time-of-flight mass spectrometer is significantly greater than the sum of a passage time through said fragmentation cell and the time-of-flight in the said second time-of-flight mass spectrometer.

47. (New) The tandem mass spectrometer of claim 46, wherein the time-of-flight in said first time-of-flight mass spectrometer is at least 10 times greater than the time-of-flight in said second time-of-flight mass spectrometer.

48. (New) The tandem mass spectrometer of claim 46, wherein an average ion energy in said first time-of-flight mass spectrometer is at least 100 times less than that in said second time-of-flight mass spectrometer.

49. (New) The tandem mass spectrometer of claim 46, wherein said pulsed ion source comprises a MALDI ion source having a pressure of about 0.1 mbar.

50. (New) The tandem mass spectrometer of claim 46, wherein said pulsed ion source comprises a radio frequency (RF) storage device and a continuous ion source selected from the group of an electrospray source, a MALDI ion source, an electron impact ion source, and electron impact with one of a chemical and photo ionization ion source; wherein ions are continuously supplied from said ion source to become accumulated and pulse-ejected from said storage device.

51. (New) The tandem mass spectrometer of claim 50, wherein said storage device comprises at least one linear multipole, supplemented by at least one DC electrode, creating a non-zero axial electric field.

52. (New) The tandem mass spectrometer of claim 46, wherein said first time-of-flight mass spectrometer comprises a linear multipole surrounded by a plurality of pulsed mirrors with an axial quadratic electric field.

53. (New) The tandem mass spectrometer of claim 46, wherein said first time-of-flight mass spectrometer comprises a two-dimensional ion tunnel surrounded by a plurality of two-dimensional DC mirrors with a quadratic electric field.

54. (New) The tandem mass spectrometer of claim 46, wherein said first time-of-flight mass spectrometer comprises at least a pair of coaxial electrodes with DC voltage applied therebetween and wherein ions are injected between said electrodes at an angle.

55. (New) The tandem mass spectrometer of claim 54, wherein ions enter and exit a gap between said electrodes through cut-off boundaries formed by a plurality of double-sided, printed-circuit boards.

56. (New) The tandem mass spectrometer of claim 46, wherein said first time-of-flight mass spectrometer comprises a planar multi-pass electrostatic time-of-flight mass spectrometer having

a two-dimensional free flight channel and a plurality of planar focusing electrostatic mirrors defined by focusing and reflecting electrodes.

57. (New) The tandem mass spectrometer of claim 46, wherein said first time-of-flight mass spectrometer comprises a cylindrical multi-pass electrostatic time-of-flight mass spectrometer having at least a pair of coaxial cylinders with radial deflection and a plurality of focusing electrostatic mirrors formed by coaxial cylinders.

58. (New) The tandem mass spectrometer of claim 46, further comprising a timed gate between said first time-of-flight mass spectrometer and said fragmentation cell and adapted to transmit ions within at least one time window.

59. (New) The tandem mass spectrometer of claim 46, wherein ions in said fragmentation cell comprise an energy adjusted by an electrostatic offset between said first time-of-flight mass spectrometer and said fragmentation cell.

60. (New) The tandem mass spectrometer of claim 46, wherein said fragmentation cell comprises a collision-induced dissociation cell filled with a gas and at least one multipole supplemented by at least one electrode.

61. (New) The tandem mass spectrometer of claim 58, wherein an ion packet within said collision-induced dissociation cell includes a time spread reduced by using a cell of less than 1 cm in length and a pressure greater than or equal to 100 mtorr.

62. (New) The tandem mass spectrometer of claim 58, wherein said fragmentation cell stores fragment ions using a modulation of an axial DC field within said cell and ejects a pulsed beam synchronized with pulses from said second time-of-flight mass spectrometer.

63. (New) The tandem mass spectrometer of claim 46, wherein said fragmentation cell comprises a pulsed-temporal and spatial-focusing lens and a target coated with a fluoro-hydrocarbon monolayer.

64. (New) The tandem mass spectrometer of claim 46, wherein said second time-of-flight mass spectrometer comprises a time-of-flight mass spectrometer having orthogonal time injection.

65. (New) The tandem mass spectrometer of claim 46, wherein said second time-of-flight mass spectrometer comprises a high current detector and transient recorder.

66. (New) The tandem mass spectrometer of claim 46, wherein said first time-of-flight mass spectrometer comprises one of a plurality of reflectors forming a quadratic potential distribution along an ion path and having a length greater than lm, using said timed gate with multiple time windows.

67. (New) The tandem mass spectrometer of claim 46, further comprising an in-line detector sequentially connected to said first time-of-flight mass spectrometer.

68. (New) A method of comprehensive tandem mass spectroscopy analysis, comprising the steps of:

(1) ejecting a plurality of parent ions having various mass-to-charge ratios from a pulsed ion source;

(2) separating said parent ions as a function of time within a first ion separator;

(3) fragmenting the time-separated parent ions;

(4) analyzing the fragmented parent ions within a first time-of-flight mass spectrometer; and

(5) time nesting the fragmented parent ion spectra acquisition corresponding to multiple parent ions per ion pulse without mixing fragment spectra of different parent ions,

wherein to improve sensitivity and throughput of tandem mass spectroscopy analysis, the step of time separating occurs within a second time-of-flight mass spectrometer and wherein the time of said parent ion separation significantly exceeds the time of both fragmentation and fragment mass analysis.

69. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 68, wherein said time of flight in said second time-of-flight mass spectrometer is at least 10 times greater than in the said first time-of-flight mass spectrometer.

70. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 68, wherein the step of pulse ejecting parent ions is performed in a MALDI ion source under vacuum of approximately 100 mtorr.

71. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 68, wherein the step of pulse ejecting parent ions includes pulsed ejection from a storage quadrupole, while ions are introduced into said storage quadrupole from a continuous ion source selected from the group of an electrospray source, a MALDI ion source having a pressure ranging between 10 mtorr and 1 atm, an electron impact ion source, an electron impact having one of a chemical and photo ionization ion source.

72. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 68, wherein the step of time separating parent ions occurs in a quadratic DC field wherein an energy of ions in said second time-of-flight mass spectrometer is at least 100 times less than in said first time-of-flight mass spectrometer.

73. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 72, wherein said step of time separating parent ions in said quadratic DC field is assisted by confining an RF field in at least one dimension, orthogonal to said quadratic DC field.

74. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 73, wherein said step of confining in said RF field is achieved along an axis where ions are injected from one end of said RF field zone and after multiple reflections in said quadratic DC field are released from an opposite end.

75. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 72, wherein the step of confining in said RF field occurs along a two-dimensional plane; and said ions are injected at an acute angle to said second time-of-flight mass spectrometer axis parallel to a gradient of said DC field; whereby said ions experience multiple reflections in said DC field while drifting in an orthogonal direction towards an exit of said RF field.

76. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 68, wherein said step of time separating said parent ions occurs in an electrostatic field wherein said energy of said parent ions in said second time-of-flight mass spectrometer is at least 10 times less than in said first time-of-flight mass spectrometer, and wherein the said effective flight path in second time-of-flight mass spectrometer is at least 30 times greater than in said first.

77. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 68, wherein said step of time separating said parent ions occurs in an electrostatic field created by a plurality of coaxial electrodes, wherein said parent ions are injected into said electrostatic field at an angle to an electrode axis, and wherein a disturbance of said electrostatic field at its boundaries is reduced by at least one double-sided, printed-circuit board.

78. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 68, wherein said step of time separating said parent ions occurs in a planar electrostatic field formed by a planar free flight channel and a plurality of planar focusing ion mirrors; and wherein said parent ions are injected at an acute angle to said second time-of-flight mass spectrometer axis and experience multiple bounces between said mirrors.

79. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 68, wherein said step of time separating said parent ions occurs in a cylindrical electrostatic field formed by a plurality of coaxial cylinders; wherein in at least one pair a radial field is applied; and wherein said parent ions are injected at an angle relative to said second time-of-flight mass spectrometer axis and experience multiple bounces between a plurality of ion mirrors.

80. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 68, further comprising the step of resolving the time separation of ions in said first time-of-flight mass spectrometer by sampling a plurality of time windows before submitting ions to said fragmenting step.

81. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 68, where said fragmenting step is achieved in one of the following processes: in energetic collisions with gas, in collision with a surface, or by light.

82. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 68, wherein the step of analyzing includes acquiring parent mass spectrum in said second time-of-flight mass spectrometer, while using said first time-of-flight mass spectrometer in a pass mode, and by sampling time windows in front of a collision cell corresponding to arrival of meaningful parent ions and acquiring fragment spectra for those time windows only, said time windows being selected on the fly, based on parent masses from a first stage of measurements.

83. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 68, further comprising the step of reconstructing a spectrum of parent ions having a predetermined set of fragment ions using a full tandem mass spectrometer data set.

84. (New) The method of comprehensive tandem mass spectroscopy analysis of claim 68, and further comprising the step of continuously introducing a flow of solvent from at least one liquid chromatograph input into a tandem mass spectrometer.